Mid-summer Ichthyoplankton Populations Of Tuktoyaktuk Harbour, N.W.T.

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ERRATA

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p.iv col.2:

line 5	larengus	should	be	harengus
line 15	cordes	"	"	cornes
line 22	machayi	"	"	mackayi
line 33	Pacifique	"	"	arctique

ERRATA

p. 4 col.2, line 10. Elginus should read Eleginus

p.21. Fig.12. Caption should read: Mean length(± SD) of...

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by

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This is the 163rd Technical Report
from the Western Region, Winnipeg

PREFACE

This report is a summary of work completed under the terms of a Department of Supply and Services contract let to the author. The work was done on behalf of the Resource Impact Division, Arctic Resource Assessment Section, Freshwater Institute, Fisheries and Oceans, Western Region. This report is published upon recommendation by Mr. M. J. Lawrence, Scientific Authority for this study.

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ABSTRACT

Ratynski, R.A. 1983. Mid-summer ichthyoplankton populations of Tuktoyaktuk Harbour, N.W.T. Can. Tech. Rep. Fish. Aquat. Sci. 1218: iv + 21 p.

The ichthyoplankton of Tuktoyaktuk Harbour, N.W.T. and adjacent waters of Kugmallit Bay was sampled by plankton net(mesh size 750 µm), during 11 July to 16 August, 1992, to determine species composition, abundance, distribution, and growth. There was also limited sampling by epibenthic sled and seine. Rainbow smelt (Osmerus mordax) was the most abundant larva in plankton net catches from the harbour (8.1• 100 m^{-3}) followed by Pacific herring (Clupea harengus pallasi) (0.6•100 m^{-3}) and saffron cod (Eleginus gracilis) (0.3•100 m^{-3}). Larval starry flounder (Platichthys stellatus), lumpenids-blackline prickleback (Acantholumpenus mackayi) and/or slender eelblenny (Lumpenus fabricii), fourhorn sculpin (Myoxocephalus quadricornis), and Arctic cod (Boreogadus saida), were also captured within the harbour. Only rainbow smelt, Pacific herring, fourhorn sculpin, and Arctic cod were obtained outside the harbour in Kugmallit Bay and smelt and herring were far less abundant than in the harbour. A partial temporal separation of larvae in the harbour occurs as a result of different spawning times. Lumpenids, fourhorn sculpin, and gadids would appear first in the ichthyoplankton under the ice followed by rainbow smelt and Pacific herring at breakup and starry flounder in August. There was also spatial separation of larvae vertically. Most rainbow smelt, Pacific herring, and fourhorn sculpin larvae were obtained from the harbour near the surface at the higher temperatures and lower salinities found above the halocline. Saffron cod, starry flounder, and lumpenids were found in the colder, more saline waters of the upper halocline. The size of smelt, herring, and sculpin at the end of August was similar to that reported for other areas in the southern Beaufort Sea. Saffron cod grew very slowly, reaching a mean total length of only 7.5 mm by mid-August. Mean total length of starry flounder in early August was 4.2 mm.

Key words: ichthyoplankton; larval fishes; Beaufort Sea; check list; abundance; distribution; growth.

RESUME

Ratynski, R.A. 1983. Midsummer ichthyoplankton populations of Tuktoyaktuk Harbour, N.W.T. Can. Tech. Rep. Fish. Aquat. Sci. 1218: iv + 21 p.

On a échantillonné l'ichthyoplancton des eaux du port de Tuktoyaktuk (T.-du-N.-O.) et de la baie adjacente de Kugmallit au moyen d'un filet à plancton (maille de grosseur 750µm) du 11 juillet au 16 août 1982 pour identifier les espèces qui le composent et déterminer leur abondance, leur distribution et leur taux de croissance. On a également prélevé quelques échantillons épibenthiques au moyen d'un traîneau et d'une seine. Dans la prise nette prélevée au filet à plancton dans les eaux du port, les larves d'éperlan arc-en-ciel (Osmerus mordax) dominaient (8,1 indiv./100 m^{-3}), puis venaient le hareng du Pacifique (Clupea harangus pallasi) (0,6 indiv./100 m^{-3}) et la morue arctique (Eleginus gracilis) (0,3 indiv./100 m^{-3}). Nous avons également capturé dans les eaux du port des larves de plie étoilée (Platichthys stellatus), d'Acantholumpenus mackayi et de lompénie élancée (Lumpenus fabricii), de chaboisseau à quatre cornes (Myoxocephalus quadricornis) et de saïda (Boreogadus saida). On n'a trouvé que de l'éperlan arc-en-ciel, du hareng du Pacifique, du chaboisseau à quatre cordes et de la saïda hors du port, dans la baie Kugmallit; l'éperlan et le hareng étaient beaucoup moins abondants dans la baie. Les larves n'apparaissent pas toutes en même temps, car le frai se produit à différentes périodes selon les espèces. Il apparaîtrait d'abord des larves d'Acantholumpenus machayi, de chaboisseau à quatre cornes et de gadidés dans l'ichthyoplancton sous la glace, puis, à la débâcle viendraient l'éperlan arc-en-ciel et le hareng du Pacifique et enfin, en août, la plie étoilée. On a également observé une séparation spatiale verticale des larves. La plupart des larves d'éperlan arc-en-ciel, de hareng du Pacifique et de chaboisseau à quatre cornes provenaient des eaux superficielles du port où la température est plus élevée et la salinité plus faible qu'à l'halocline. La morue du Pacifique, la plie étoilée, Acantholumpenus mackayi et la lompénie élancée provenaient des eaux plus froides et plus salées de l'halocline supérieure. La taille de l'éperlan, du hareng et du chaboisseau à la fin d'août correspondait à celle des spécimens mesurés dans d'autres régions du sud de la mer de Beaufort. La morue arctique se développait très lentement, sa longueur totale n'étant que de 7,5 mm à la mi-août. Quant à la plie étoilée, sa longueur totale moyenne était de 4,2 mm au début d'août.

Mots-clés: ichthyoplancton; poissons à l'état larvaire; mer de Beaufort; liste; abondance; distribution; taux de croissance.

INTRODUCTION

Tuktoyaktuk Harbour is a supply base for hydrocarbon explorations in the southern Beaufort Sea. There has been considerable shoreline development, vessel and barge traffic, and dredging within the harbour. There have also been minor oil spills. These environmental disturbances could increase in the future and have a detrimental effect on the harbour's fish community. The early life stages of fishes are particularly sensitive to environmental disturbances. Larval mortality is usually very high and even a small increase in its rate can greatly reduce year class strengths (Bagenal and Braum 1978). The emphasis of several previous fisheries studies of the harbour has been on adult and juvenile fishes (Slaney, F.F. and Co. 1973; Beak Consultants 1975; Galbraith and Hunter 1975; Byers and Kashino 1980; Bond 1982; Hopky and Ratynski 1983). Adult and juvenile fishes of twenty species have been found in the harbour including marine, anadromous, and freshwater forms (Table 1). There is evidence that several of the marine species spawn within the harbour (Bond 1982; D.V. Gillman, personal communication, Department of Fisheries and Oceans, Winnipeg). Larval fish tows were previously conducted in the Tuktoyaktuk region during 14-29 July, 1970 (Sutherland 1982) and morphological development of fourhorn sculpin larvae described by Khan and Faber (1974). However, there is no published information on other planktonic larvae from the harbour.

The objectives of this study were to determine the species composition of the ichthyoplankton, abundance and distribution of larvae, and their growth. Sampling was conducted during July and August, 1982.

DESCRIPTION OF THE STUDY AREA

Tuktoyaktuk Harbour is situated in the southern Beaufort Sea at the eastern periphery of the Mackenzie Delta on the Tuktoyaktuk Peninsula (Fig. 1, 2). Maximum depth in the harbour is 26 m and depths in excess of 10 m are frequent (Barber 1968). Outside the harbour, in Kugmallit Bay, depth is less than 6 m within 22 km of Tuktoyaktuk (Barber 1968). A distinctive physical feature of the harbour is a strong salinity gradient. Under ice cover, salinity can reach less than 1‰ above the halocline and more than 30‰ below the halocline (Barber 1968). In summer, salinities of 11-13‰ above and 26-29‰ below the halocline are normal. Temperature in winter can vary from 0°C at the surface to -0.5°C at the bottom while in summer surface waters can reach 15°C and bottom temperatures remain near 0°C. (Barber 1968).

Barber (1968) discusses the mechanisms by which salinity fluxes in the harbour occur.

MATERIALS AND METHODS

EQUIPMENT

Samples were collected with a Wisconsin style plankton net having a mouth diameter of 0.5 m and mesh size of 750 µm. End buckets were constructed from ABS plastic. A 5.5 kg bronze cable depressor was attached by a 1 m line to the tow rope, approximately 1 m in front of the plankton net. This helped maintain the sampler on a horizontal path and constant depth during subsurface tows.

Depth of subsurface horizontal tows was determined by the formula: $D = L \cos a$ where D is the depth of the net, L is the length of the tow rope from the water surface to sampler, and a is the cable angle.

Distance towed, velocity, and volume sampled was determined from a centre mounted General Oceanics, Inc. Digital Flowmeter (Model #2030). Tow velocity was normally, but not always, 1.0 $m \cdot sec^{-1}$. One complete tow consisted of releasing the net, towing usually for five minutes, and then retrieving the net. Two replicate tows per station or depth were generally performed. Volume sampled was calculated from the time the net left the boat until it returned. Because there was no closing mechanism, samples from greater depths were subject to contamination as they were brought to the surface. However, retrieval time was normally a minor portion of the total time.

On three occasions, the above described plankton net was mounted, without flowmeter, to a sled (see Dovel 1964) and epibenthic tows performed. A beach seine of 12 m x 1.4 m and mesh of 6 mm (stretched mesh measure) was also utilized to obtain samples of larvae.

Salinity and temperature profiles were measured on several occasions during July and August with an Applied Microsystems CTD-12 salinometer with Model #735 computer.

DESIGN

Within Tuktoyaktuk Harbour, sampling via plankton net tows was performed at twelve stations. These were in locations ranging from peripheral areas (shallow bays and stream mouths or inlets) to areas in the harbour proper (Fig. 2). Surface tows (where the plankton net sampled between 0-1.0 m) were performed at all stations. At two mid-harbour stations (13 and 14), samples were also obtained from various depths: surface (0-1.0 m), near surface (where the plankton net sampled between 2.5-3.9 m), upper halocline (where the plankton net sampled between 4.0-7.5 m), and lower halocline (where the plankton net sampled between 7.6-10.5 m). These divisions were based on the temperature and salinity profiles. Salinity at the surface ranged from 2-6‰ and temperature from 9.5-14.0°C (Fig. 3). Salinity at the bottom was 30‰ and temperature 1.0°C. The halocline ranged from about 4 m to 10 m (Fig. 3). Surface and near surface depth ranges were characterized by highest water temperatures and lowest salinities during the period of study (Fig. 3) but presumably differing in light intensities (all tows were made during daylight). The upper halocline range (4.0-7.5 m) was characterized by a rapid decrease in temperature and an increase in salinity from surface values. Temperature

and salinity continued to change until they stabilized at their lowest and highest levels, respectively, in the 7.6-10.5 m depth range. Total depth ranged from approximately 10-15 m at Station 13 and from 18-25 m at Station 14.

Plankton net tows were also performed at two depth ranges, 0-1.0 m and 2.5-3.9 m, at one station in Kugmallit Bay, approximately 3 km from Tuktoyaktuk (Fig. 2). Maximum depth there was 5 m.

Epibenthic tows were performed in the harbour on 29 July and 8 August (total of four tows). Outside the harbour, epibenthic tows were also performed on 19 July but no specimens were captured. Samples of larvae were obtained by beach seining during 8 to 21 July and 24 and 25 August. The July samples were made up of larval and juvenile coregonids and have not been included in this report.

ANALYSES

Immediately following plankton net retrieval, the entire sample was preserved in a weak non-buffered formaldehyde solution. Contents were later sorted in the lab. Larvae were stored in 15 mL dark glass bottles, with a 5% non-buffered solution of formaldehyde, and kept in a dark place to preserve pigmentation.

Larvae were identified to species, when possible, with the aid of a number of sources including Rass (1949), Orcutt (1950), Yusa (1957), Stevenson (1962), Taylor (1964), Khan and Faber (1974), Faber (1976), and Dunn and Vinter (1982). Basic morphological characteristics, such as anus position, fin types, etc. and type and extent of melanophore pigmentation were utilized to distinguish among the various species. Illustrations of captured larvae indicate these characteristics for each. The sources listed above should be consulted for more thorough descriptions and for intraspecific changes associated with developmental stages. The terminology of Hubbs (1943) for early stages of fishes was utilized. Embryo refers to developmental stages previous to hatching. Larva is divisible into prolarval (still bearing yolk) and postlarval (yolk sac absorbed) stages. Juvenile refers to young that are similar to adults.

Larvae were enumerated and catch-per-unit-effort (CPUE) expressed as the the number captured per 100 m^3. Samples were combined by period and depth range for calculation of CPUE. Periods were one week long except for the initial period which lasted two days. These preliminary samples were kept separate because a flowmeter was not used for all tows on 11, 12 July and volumes were estimated. The volume sampled varied with period.

Total length was measured with an ocular micrometer to 0.1 mm on specimens up to 18.0 mm, beyond which length was measured with a ruler to the nearest 0.5 mm. Usually, up to ten rainbow smelt were measured for each day and all specimens measured (where possible) for other species.

RESULTS AND DISCUSSION

The larvae of six families and of at least seven species were captured in Tuktoyaktuk Harbour during this study. These were the Osmeridae - rainbow smelt, Clupeidae - Pacific herring, Gadidae - saffron cod and Arctic cod, Pleuronectidae - probably starry flounder, Lumpenidae - not identified to specific level but would be the blackline prickleback and/or the slender eelblenny, and Cottidae - fourhorn sculpin (Table 1).

IDENTIFICATION

Rainbow smelt and Pacific herring

Larvae are characterized by 1) the anus situated within the rear third of the body, 2) low set pectoral fins, and 3) isomeric row pigmentation (i.e. identical melanophores in rows corresponding closely to the number of myomeres or future rays of unpaired fins) (Rass 1949). In rainbow smelt, there is a single medio-ventral isomeric row of melanophores (Rass 1949). On postlarval Pacific herring, the abdominal pigmentation consists of two rows of melanophores, widely separated anteriorly but close together from the middle of the body to the anus (Stevenson 1962; Taylor 1964). This difference in abdominal pigmentation was the major characteristic used to separate small rainbow smelt (Fig. 4) and Pacific herring (Fig. 5) larvae. Neither species had dorsal melanophore pigmentation. In larger larvae with formed fins, smelt possess an adipose fin while the herring do not.

Saffron cod and Arctic cod

These larvae are characterized by the 1) anus located in the anterior half of the body, 2) distended pre-anal section of the body, 3) looped intestine, 4) narrow based pectoral fins situated medio-laterally, and 5) melanophore pigmentation consisting of dorsal and ventral anisomeric rows (Rass 1949). In prolarvae and early postlarvae, these rows are broken into separate bars or girdles.

One type of gadid larva captured was smaller, 5.6-8.0 mm, and at an earlier developmental stage than the other, which ranged from 12.5-14.6 mm long. The smaller larvae, identified as saffron cod, were characterized by 1) the presence of ventral gut pigment, and 2) longer ventral anterior and posterior postanal pigment bars than the corresponding dorsal bars (Fig. 6). Similar sized Arctic cod lack ventral gut pigment and the dorsal postanal pigment bars are longer than the ventral ones (Dunn and Vinter 1982). In freshly captured specimens, the dorsal melanophore bars were surrounded by xanthophores (yellow) and eyes were blue. On 13 August, the pigment bars formed a continuous melanophore row, both dorsally and ventrally, on a saffron cod measuring 7.5 mm. On two other specimens (7.0 and 7.5 mm), only the ventral pigment bars had joined; on an 8.0 mm saffron cod, the ventral bars were joined and the dorsal ones only partially. This suggests an earlier expansion of the ventral melanophore bars of saffron cod as was found by Dunn and Vinter (1982).

The larger gadid larvae, identified as Arctic cod, can be distinguished from similar sized saffron cod by 1) the absence of ventral gut melanophores posterior to the pectoral fins, 2) the medio-lateral line of pigment progressing anteriorly no further than the vent, and 3) mid-line ventral postanal pigment with a scattering of melanophores anteriorly on each side (Dunn and Vinter 1982). These characteristics were apparent on Tuktoyaktuk specimens (Fig. 7). In Arctic cod, the dorsal stripes become continuous before the ventral stripes (Dunn and Vinter 1982). This was apparent in smaller Arctic cod obtained during this study.

For a complete discussion of characteristics distinguishing the two species, Dunn and Vinter (1982) should be consulted. The Arctic cod was also described by Schmidt (1905).

Starry flounder

Pleuronectid larvae are characterized by 1) a laterally compressed body, 2) narrow based pectoral fins, and 3) mixed pigmentation with a predominance of aggregations (Rass 1949). The anus is located on the anterior half of the body and pectoral fins are positioned medio-laterally.

The pleuronectid larvae from the harbour have been identified as starry flounder (Fig. 8, 9). Most were less than 4.3 mm whereas the only other pleuronectid occurring in the harbour, the Arctic flounder (Liopsetta glacialis) (Bond 1982; Hopky and Ratynski 1983), is 5.6 mm in total length at hatching (Aronovich et al. 1975). However, Tuktoyaktuk Harbour specimens showed some differences as compared to previous descriptions. Specimens less than 4.3 mm had aggregations of melanophores on the dorsal and posterior portion of the gut (Fig. 8) as did starry flounder described by Orcutt (1950) and Yusa (1957). Orcutt (1950) also described melanophores on the body at the bases of the fin dorsally and ventrally, but only an irregular ventral postanal pigmentation could be detected in Tuktoyaktuk Harbour specimens. Yusa (1957) also observed melanophores dorsally and described an aggregation almost halfway between the anus and the end of the body. A concentration of melanophores was present laterally in some of the Tuktoyaktuk specimens (Fig. 8).

Approximately two weeks previous to the capture of these larvae, planktonic eggs were collected that were orange in colour, about 1.1 mm in diameter, and without oil globules. They have been identified as the eggs of starry flounder. Yusa (1957) describes starry flounder eggs as transparent, pale orange pink, with a diameter of 0.991 mm, and without oil globules. In comparison, the planktonic eggs of Arctic cod and Arctic flounder are 1.7-1.9 mm and 1.5-1.7 mm in diameter, respectively (Aronovich et al. 1975). These species also spawn much earlier in the year.

Three larger pleuronectids (6.0-6.3 mm) (Fig. 9) differed in pigmentation. Dorsally, there were scattered melanophores half way between the anus and the caudal end. Ventrally, gut pigment consisted of three rows; the middle row was comprised of dash-like melanophores and the lateral rows of stellate melanophores. Ventral postanal pigmentation consisted of two anisomeric rows of melanophores. Unfortunately, Orcutt (1950) and Yusa (1957) were unable to describe larvae past lengths of 3.5 mm and 4.55 mm, respectively. However, these larger pleuronectid larvae are probably starry flounder (D.J. Faber, personal communication, National Museum of Natural Sciences, Ottawa).

Lumpenids

Larvae are characterized by 1) the position of the anus just anterior of the middle of the body, 2) their tube-like intestine, 3) the medio-lateral position of wide-based pectoral fins, 4) a row of melanophores along either side of the intestine, and 5) the medio-ventral isomeric row of melanophores found from the anus to the caudal fin (Faber 1976). Lumpenids do not possess head melanophores or internal melanophores along the notochord (Faber 1976). Lumpenid larvae from the harbour were readily identified by these distinguishing characteristics (Fig. 10).

No attempt has been made to identify the larvae to specific level. Descriptions of blackline prickleback and slender eelblenny of the size captured in Tuktoyaktuk Harbour (< 21.5 mm) do not exist. However, Walters (1955) described specimens, apparently slender eelblenny, ranging from 39-50 mm (standard length) and Tokuya and Amaoka (1980) described juvenile blackline prickleback of 36.00-38.62 mm (total length).

Fourhorn sculpin

Sculpin larvae are characterized by 1) the anus located in the anterior half of the body and 2) the wide-based pectoral fins (Rass 1949). Fourhorn sculpin have peritoneal and cephalic melanophore concentrations, and an anisomeric row of melanophores medio-ventrally (Khan and Faber 1974). These characteristics were apparent on larvae identified as fourhorn sculpin from the harbour (Fig. 11). Zviagina (1963) and Khan and Faber (1974) should be consulted for a detailed description of larval fourhorn sculpin at various developmental stages. No other cottid occurs in the harbour (Bond 1982; Hopky and Ratynski 1983).

ABUNDANCE AND DISTRIBUTION

Rainbow smelt

The most abundant species in the harbour was rainbow smelt, with 1 164 larvae ($8.1 \cdot 100\ m^{-3}$) captured in plankton nets tows from 11 July to 16 August (Table 2). They were the most abundant species, overall, in the surface waters at all stations (Table 3). Total CPUE values were the highest of any species at all depth ranges, but greatest smelt abundance was at the surface and lowest at 7.6-10.5 m (Tables 2, 4). This differs with vertical distribution in the Miramichi River, New Brunswick, where 90% of rainbow smelt larvae were within 1.52 m of the bottom during the day in water 11-12 m deep (McKenzie 1964). Perhaps larvae in Tuktoyaktuk Harbour were avoiding the more saline and colder

waters found at greater depths.

CPUE of surface tows (all stations combined) decreased as the season progressed from an initial 34.2•100 m^{-3} to 0.5•100 m^{-3} for the last period (Table 3). Initially, smelt were most numerous in shallow areas peripheral to the main harbour, especially at Stations 8, 9, and 17 (Table 3; Fig. 2). Subsequently, CPUE values decreased at the periphery and, except at Station 11 where the decline was small, were lower than for the main harbour stations. Low catches in the latter part of the sampling season probably results from active gear avoidance by larger larvae and not to an absence of smelt from the harbour. Several hundred larvae were captured by beach seining on the 24 and 25 August.

In Kugmallit Bay (Station 16), rainbow smelt was again the most abundant species, but far less numerous than inside the harbour (Table 5). Nine larvae (1.0•100 m^{-3}) were captured at the surface, all during 13-19 July. Only one specimen (0.1•100 m^{-3}) was obtained at the 2.5-3.9 m depth range during 27 July - 2 August.

Larvae of this species have been previously reported in Tuktoyaktuk Harbour (Bond 1982) and in Kugmallit Bay (Byers and Kashino 1980). They have also been reported in the Beaufort Sea on the Yukon coast (Kendel et al. 1975), in the Mackenzie Delta (Percy 1975), and along the Tuktoyaktuk Peninsula (Jones and Den Beste 1977; Lawrence et al. in prep.). Smelt were the second most abundant larvae at Tuft Point (Jones and Den Beste 1977). Density for plankton net tows there ranged from 0 to 18.2•100 m^{-3}.

Pacific herring

The second most abundant species in the harbour was the Pacific herring, with 89 larvae (0.6•100 m^{-3}) captured (Table 2). Larvae were present at all stations, except 11 and 18 (Table 3), and at all depth ranges, except 7.6 m to 10.5 m (Tables 2, 4). Greatest abundance, overall, was in surface waters (Tables 2, 4). Larval herring on the coast of British Columbia were also in greatest abundance near the surface (0-0.9 m) (Stevenson 1962). The highest total CPUE was 3.7•100 m^{-3} at Station 7 (Reindeer Creek) with the greatest catch there (10.9•100 m^{-3}) occurring during 11-12 July (Table 3). Thereafter, catches were negligible or nil probably because larvae were able to avoid capture by plankton net. Eleven late postlarval herring were captured by seining on 24 August.

In Kugmallit Bay, only two Pacific herring were captured, one at each depth range (Table 5).

Larval and juvenile Pacific herring have been previously obtained along the Tuktoyaktuk Peninsula in mid-July (Hunter 1979), in late August (Jones and Den Beste 1977), and in September (Lawrence et al. in prep.). None were captured in the Mackenzie Delta (Percy 1975) or on the Yukon coast (Kendel et al. 1975).

Saffron cod

The third most numerous species captured in the harbour was the saffron cod with 37 specimens obtained (0.3•100 m^{-3}) (Table 2). Only one larva was taken from the surface, at Station 10 (Tables 2, 3). All other larvae were captured below the surface depth range at mid-harbour Stations 13 and 14. Total CPUE was highest from 4.0-7.5 m (0.9•100 m^{-3}) and next highest from 2.5-3.9 m (0.4•100 m^{-3}) (Tables 2, 4) with all but one larva from the latter depth range captured at or below 3.7 m. Newly hatched navaga, Eleginus navaga (Pallas), displayed positive phototaxis and concentrated near the water surface in aquaria (Aronovich et al. 1975). Saffron cod larvae presumably react similarly, however the intense stratification of Tuktoyaktuk Harbour affected their normal vertical distribution and resulted in concentration of larvae below the surface at the halocline. A single larva was obtained below 7.5 m but it may have been captured during net retrieval through upper layers.

Saffron cod larvae have not previously been reported from the Beaufort Sea. This is not surprising as there has been no appropriate sampling effort in the offshore environment, where optimal salinities for embryonic development (21‰-35‰, Aronovich 1977) are to be found. The brackish, estuarine water of the Mackenzie and Kugmallit Bay areas where most sampling effort has taken place does not appear well suited for saffron cod larval development. Tuktoyaktuk Harbour evidently provides a suitable inshore spawning and rearing area.

Starry flounder

Twenty-one larval starry flounder (0.1•100 m^{-3}) were caught (Table 2), all from mid-harbour Stations 13 and 14, below the surface. Larvae, which occurred in two size groups, first appeared on 2 August and none were captured after 8 August. The smaller larvae (Fig. 8) were all obtained from a depth of 4.0-7.5 m. Fourteen (1.4•100 m^{-3}) were captured during the 27 July - 2 August period and four (0.7•100 m^{-3}) during 3-9 August (Table 4). The three larger larvae (Fig. 9) were obtained from 2.5-3.9 m during 3-9 August (Table 4). Most of the starry flounder eggs sampled during 14-15 July were also obtained below the surface from a depth of 4.0-10.5 m. The eggs (Orcutt 1950; Yusa 1957) and nonmetamorphosed larvae (Policansky and Sieswerda 1979) of starry flounder are normally found at or near the surface of seawater. However, intense stratification of the harbour has altered the expected vertical distribution.

No starry flounder larvae were obtained in Kugmallit Bay, although a few eggs were obtained there during 14-15 July.

Although juvenile starry flounder have been recorded from many locations on the coast of the southern Beaufort Sea (Kendel et al. 1975; Percy 1975; Jones and Den Beste 1977; Bond 1982), there are no reports of larvae.

Lumpenids

Eight lumpenids (0.1•100 m^{-3}) were captured (Table 2), all from mid-harbour Stations 13 and 14. Most were captured in the area of the upper halocline. Of five specimens obtained from 2.5-3.9 m during 13-19 July (Table 4), only

one was taken above 3.7 m. The remaining specimens were captured from the 4.0-7.5 m range during 27 July - 2 August and during 3-9 August (Table 4). No lumpenid larvae were captured at the surface or from 7.6-10.5 m. Salinities in the area of the upper halocline ranged from 5-19‰ and average temperatures from 12-7°C (Fig. 3). In the estuarine waters of southeastern James Bay, slender eelblenny larvae were taken below the surface at salinities of 4‰-17‰ and temperatures of -1.0 to 6.0°C (Ochman and Dodson 1982). CPUE in James Bay never exceeded 1·100 m^{-3} (Ochman and Dodson 1982).

No lumpenid larvae were captured outside the harbour in Kugmallit Bay. Apparently, there have been no previous captures of these larvae in the Beaufort Sea.

Fourhorn sculpin

Only six fourhorn sculpin larvae were captured in Tuktoyaktuk Harbour (Table 2). Five of these were obtained at the surface, all at near shore areas (Stations 7 and 10) (Table 3). Only one specimen was obtained offshore, at Station 14, from a depth of 7.6-10.5 m (Table 4). Three larvae were also captured from the surface waters of Kugmallit Bay during 13-19 July (Table 5). Khan and Faber (1974) also found that fourhorn sculpin larvae were generally present in shallow pelagic areas and along shore.

When sampling by plankton net began in mid-July, sculpin larvae were well developed and highly capable of avoidance. Thus, true abundance of sculpin in the harbour is probably much greater than present data indicates. No larvae were captured by plankton net after 24 July, but both larvae and juveniles were obtained on 24 August by seining. In 1980, young-of-the-year sculpin were not captured in the harbour, in small mesh seines, until 13 August (Bond 1982).

Fourhorn sculpin are common in the Beaufort Sea. Larvae have been reported along the Yukon coast (Kendel et al. 1975; Griffiths et al. 1975), in the outer Mackenzie Delta (Percy 1975), and along the Tuktoyaktuk Peninsula (Jones and Den Beste 1977; Lawrence et al. in prep.). They were the most abundant larvae at Tuft Point (Jones and Den Beste 1977).

Arctic cod

Only three Arctic cod were captured in the harbour (Table 2). Two were obtained at 2.5-3.9 m during 13-19 July (1.1·100 m^{-3}) and the third at 4.0-7.5 m during 20-26 July (0.2·100 m^{-3}) (Table 4). Three specimens (0.7·100 m^{-3}) were also caught in the surface waters of Kugmallit Bay during 13-19 July (Table 5).

Elsewhere, Arctic cod larvae have been found in large numbers. Arctic cod (mostly larvae but with some juveniles) constituted 90% of the total catch (n=335) from Amundsen Gulf in 1973 and 73% of the total catch (n=5 648) from Mackenzie Bay in 1975 (Hunter 1979). However, actual densities of larvae ranged from 0 to 0.3·100 m^{-3} per trawl in Amundsen Gulf and from 0.01 to 1.6·100 m^{-3} in Mackenzie Bay. Over 85% of all ichthyoplankton in Lancaster Sound and western Baffin Bay in 1976 and 1978 were Arctic cod (Sekerak 1982). Densities there ranged up to 120·100 m^{-3} for a single high speed Miller sampler tow. In Simpson Lagoon, Alaska, Arctic cod represented 83% of larvae in 1977 (Craig et al. 1982). An overall density of 7.8·100 m^{-3} was obtained for Simpson Lagoon via 1 mm mesh plankton net. Although there was undoubtedly active avoidance by advanced larvae of the sampling gear, results from this study indicate low relative abundance of Arctic cod larvae in the Tuktoyaktuk area. No larvae were captured in seine hauls at the end of August, 1982 and few adult cod were captured in the harbour during 1981 (Hopky and Ratynski 1983).

LENGTH AND GROWTH

Rainbow smelt

Total length of rainbow smelt in Tuktoyaktuk Harbour ranged from 9.5-36 mm during the sampling period. Larvae are reported to be 5 mm (standard length) at hatching (McKenzie 1964). By 11 July, mean length in the harbour was already 12.4 mm and no prolarvae were encountered. Mean length of seine captured larvae was 31.2 mm on 24 August (Fig. 12). Plankton net samples gave a good estimate of growth until the end of July after which only smaller larvae were captured. This may have been the result of a change in vertical distribution with increase in length and not entirely the result of active avoidance because larger larvae were susceptible to capture by the epibenthic sled (Fig. 15).

Growth of smelt in the harbour was similar to that found near Tuft Point, further east on the Tuktoyaktuk Peninsula, where larvae were 16.4 mm by mid-July and 28 mm by late August, 1977 (Jones and Den Beste 1977). Depending on location, the mean fork length of smelt along the Tuktoyaktuk Peninsula ranged from 24.7 to 27.3 mm in the first week of September, 1978 (Lawrence et al. in prep.). On the Yukon coast, larvae at Stokes Lagoon ranged in fork length from 19-28 mm on 18 July, 1975 (Kendel et al. 1975). Near the mouth of the West Channel of the Mackenzie River, they ranged from 24-34 mm (fork length) in early August (Percy 1975).

Pacific herring

Length of Pacific herring ranged from 7.5-33 mm with a mean of 8.8 mm on 11 July (plankton net samples) and 27.3 mm on 24 August (beach seine samples) (Fig. 12). At Tuft Point, mean length of herring larvae was 32.4 mm by 26 August to 3 September, 1977 (Jones and Den Beste 1977). By the third week of September, mean fork length elsewhere along the Tuktoyaktuk Peninsula was 37 mm (Lawrence et al. in prep.). Five prolarvae measured 7.5-9.2 mm; two were captured on 12 July, one on 20 July, and the last two as late as 2 August which suggests an extended or secondary spawning period. Herring are 6 mm at hatching and the yolk sac is absorbed on specimens as small as 6 mm and as large as 10 mm (standard lengths) (Stevenson 1962).

Only smaller herring were susceptible to capture by plankton net after the end of July. Active gear avoidance increased with increased

herring length, but this could have been at least partially alleviated by sampling during twilight. Stevenson (1962) found that larger larvae were more common in night samples.

Saffron cod

Total length ranged from 5.6-8.0 mm, but only one specimen was smaller than 6.2 mm and one larger than 7.5 mm. Mean length was 6.5 mm on 15 July and reached 7.5 mm on 13 August (Fig. 12). All specimens were postlarvae. Saffron cod hatch at 3.5 mm (Mukhacheva 1957 as cited by Dunn and Vinter 1982). A 34 mm saffron cod, captured near Tuft Point on the Tuktoyaktuk Peninsula on 30 August, 1977, was considered to be a young-of-the-year by Jones and Den Beste (1977). Perhaps it was in its second year of growth.

Starry flounder

Larvae are 1.9-2.1 mm, according to Orcutt (1950), and 2.6-3.4 mm, according to Yusa (1957), at hatching. Just two weeks after sampling starry flounder eggs, mean length of larvae from 2-8 August was 4.2 mm (n=21) and the range was 3.4-6.3 mm. Six prolarvae, 4.0-4.3 mm, were captured on 2 August but none on 8 August. Specimens showed no signs of metamorphosis. This begins at 7 mm (standard length) and no growth occurs until its completion (Policansky and Sieswerda 1979). Comparisons of larval growth with other areas in the Beaufort Sea are not possible because few other specimens have been sampled. Juvenile starry flounder as small as 28 mm have been found in Tuktoyaktuk Harbour in late summer (Bond 1982). Based on the size of pleuronectids obtained in this study, these juveniles were probably approaching the end of their second growing season.

Lumpenids

Larval lumpenids captured on 14-15 July ranged in length from 15.8-17.3 mm. The mean was 16.6 mm (n=5). On 31 July, two specimens of 20 mm and 21.5 mm respectively were caught. Another specimen was 18 mm on 8 August. Juvenile blackline prickleback were 36.0-38.6 mm on 2 June, 1978 in the waters off Hokkaido, Japan (Tokuya and Amaoka 1980). Young-of-the-year slender eelblenny in southeastern James Bay were 15-25 mm, standard length, in June 1979 (Ochman and Dodson 1982). Larvae, some with yolk sacs, measured 10-20 mm at the end of May, 1980 (Ochman and Dodson 1982).

Fourhorn sculpin

Larvae of the fourhorn sculpin ranged from 10.6-17.1 mm and had a mean length of 13.5 mm (n=8) during 12-24 July. This was less than found elsewhere along the Tuktoyaktuk Peninsula for similar periods. During 15-25 July, 1977 larvae averaged 17.8 mm at Tuft Point (Jones and Den Beste 1977). Lawrence et al. (in prep.) found a mean of 19.0 mm on 20 July 1979 during a coastal survey of the Tuktoyaktuk Peninsula. However, the size differences may be attributable to gear avoidance and selectivity. In the Tuktoyaktuk Harbour study, July specimens were captured by plankton net (easily avoided) while they were taken by trawls and/or seines (selecting for larger specimens) in the other studies. Seine captured specimens from the harbour on 24 August averaged 34 mm and ranged from 24.5-41 mm. This is similar to the mean of 32.3 mm found by Jones and Den Beste (1977) for 2 August to 3 September and to the 33.0 mm reported by Lawrence et al. (in prep.) for the first week of September, 1978. In 1980, modal length of seine captured larval sculpin in Tuktoyaktuk Harbour was 30-34 mm by the latter part of August (Bond 1982).

Arctic cod

The smallest Arctic cod was 12.5 mm on 15 July and the largest was 14.6 mm on 25 July. Arctic cod are 5.5 mm at hatching (Aronovich et al. 1975) and yolk resorption is completed by approximately 6.5 mm (Rass 1968). In Simpson Lagoon, Alaska, fork length averaged 7.8 mm (range of 6-11 mm) on 21 July and 19.0 mm (range of 12-29 mm) on 14 September, 1977 (Craig et al. 1982). In Lancaster Sound and western Baffin Bay, mean total length of larvae was 9 mm on 23 July and 28 mm on 6 October, 1978 (Sekerak 1982).

GENERAL DISCUSSION

Temporal and spatial segregation of larvae of the species sampled was demonstrated by the data and resulted from apparent differences in depth and temperature/salinity preferences of larvae. Several fish species spawn in the harbour during winter and these larvae hatch under ice cover. The slender eelblenny, usually found at salinities of 25.5‰ or more, spawn from October to November (Andriyashev 1954). In 1981, females of both slender eelblenny and blackline prickleback were approaching a ripe condition at Tuktoyaktuk by September (unpublished data). Arctic cod spawn from December to the end of March (Rass 1968) while fourhorn sculpin spawn from mid-December through January (Morrow 1980). The spawning period of Arctic flounder runs from January to March at salinities of 27-28‰ and that of saffron cod from December to February (Andriyashev 1954). In Tuktoyaktuk Harbour, there is evidence of fourhorn sculpin spawning in January and of Arctic flounder and saffron cod spawning in March (Bond 1982).

Rainbow smelt, Pacific herring, and starry flounder are spring and early summer spawners. Rainbow smelt spawn, in northern areas from May to June (Andriyashev 1954), predominately in freshwater streams, but also in the tidal zone of estuaries (Bigelow and Schroeder 1953; McKenzie 1964). It is unclear whether they actually spawn within the harbour. Larval smelt were initially abundant in several shallow areas of the harbour seemingly suitable for estuarine spawning; however, Bond (1982) found no evidence for rainbow smelt spawning in the harbour and suggested the Mackenzie River or its tributaries as sources of larvae. Pacific herring usually spawn in protected waters within the intertidal zone near shore (Taylor 1964) and in Tuktoyaktuk Harbour in mid-June (Bond 1982; D.V. Gillman, personal communication. Starry flounder spawn in the harbour from late June to early July (Bond 1982). During the present study, the

planktonic eggs of this species were sampled on 14 and 15 July.

A partial temporal separation of larvae in the harbour results from differences in spawning and hatching times. Larval lumpenids, Arctic cod, fourhorn sculpin, Arctic flounder, and saffron cod make up the ichthyoplankton in early spring before ice breakup. When sampling began in mid-July, rainbow smelt and newly hatched Pacific herring were the major components of the ichthyoplankton. Catches of lumpenids and sculpin at this time were low probably because the increased size of these larvae allowed them to more easily avoid capture; there was also a concomitant change in lifestyle (i.e. from planktonic to demersal) which made these larvae less vulnerable to capture by plankton nets. No Arctic flounder were captured, probably because they had already metamorphosed and become demersal. Arctic cod are probably never a major component of the ichthyoplankton of Tuktoyaktuk Harbour. Saffron cod grew slowly (≤ 8.0 mm by mid-August) and remained vulnerable to capture throughout the study period. Finally, newly hatched starry flounder made their appearance on 2 August.

Spatial separation of larvae was demonstrated by the data and resulted from differences in depth and temperature/salinity preferences. Rainbow smelt and Pacific herring were most abundant in the warmer/less saline waters above the halocline. Although the data is limited, it indicates that fourhorn sculpin frequented brackish surface waters at shallow depths near shore, as also found by Khan and Faber (1974). Lumpenids, saffron cod, and starry flounder were limited to mid-harbour stations and most prevalent in the colder/more saline waters near the upper part of the halocline. Planktonic larvae of all species were rare below 7.5 m. No lumpenids, saffron cod, or starry flounder larvae were captured outside the harbour in the shallow waters of Kugmallit Bay. Rainbow smelt and Pacific herring were present, but CPUE was far less than inside the harbour. This suggests the harbour is more important as a spawning and/or nursery area for these species. Successful spawning of lumpenids, gadids, and pleuronectids in the harbour may depend on the saline bottom layer of water found there. The harbour is of critical importance to the blackline prickleback which is restricted, in Arctic Canada, to Tuktoyaktuk Harbour and Liverpool Bay (McAllister, in prep.).

The ichthyoplankton present in Tuktoyaktuk Harbour during 11 July - 16 August, 1982 were identified by this study and information provided on their relative abundances, temporal and spatial distributions, and growth. However, additional sampling is desirable to further quantify the differences found. Future researchers should endeavour to utilize a wider variety of sampling equipment including plankton nets and Miller high speed samplers (Miller 1961), especially for reduction of net avoidance. Use of an epibenthic sampler would provide information on demersal forms such as young-of-the-year zoarcids, advanced lumpenid and cottid larvae, and metamorphosed pleuronectids. Concurrent small mesh seining may sample some species in shallow inshore waters as they disappear from the plankton. Attempts should also be made to sample eggs and larvae under the ice to reveal exact spawning/hatching times of the various species.

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Table 1. Fish species occurring in Tuktoyaktuk Harbour.[1,2]

Common Name	Latin Name	Abbreviation	
Pacific Herring	*Clupea harengus pallasi* Valenciennes	PCHR	
Arctic Cisco	*Coregonus autumnalis* (Pallas)	ARCS	
Lake Whitefish	*C. clupeaformis* (Mitchill)	LKWT	
Broad Whitefish	*C. nasus* (Pallas)	BDWT	
Least Cisco	*C. sardinella* Valenciennes	LSCS	
Inconnu	*Stenodus leucichthys* (Güldenstadt)	INCO	
Rainbow Smelt	*Osmerus mordax* (Mitchill)	RNSM	
Pond Smelt	*Hypomesus olidus* (Pallas)	PDSM	
Northern Pike	*Esox lucius* Linnaeus	NRPK	
Longnose Sucker	*Catostomus catostomus* (Forster)	LNSK	
Arctic Cod	*Boreogadus saida* (Lepechin)	ARCD	
Saffron Cod	*Eleginus gracilis* (Tilesius)	SFCD	
Burbot	*Lota lota* (Linnaeus)	BRBT	
Shulupaoluk (or Eelpout)	*Lycodes jugoricus* Knipowitsch	ELPT	
Ninespine Stickleback	*Pungitius pungitius* (Linnaeus)	NSSB	
Blackline Prickleback	*Acantholumpenus mackayi* (Gilbert)	BLPB	LUMP
Slender Eelblenny	*Lumpenus fabricii* (Valenciennes)	SLEB	LUMP
Fourhorn Sculpin	*Myoxocephalus quadricornis* (Linnaeus)	FHSC	
Arctic Flounder	*Liopsetta glacialis* (Pallas)	ARFL	
Starry Flounder	*Platichthys stellatus* (Pallas)	STFL	

[1]from Bond (1982) and Hopky and Ratynski (1983).

[2]common and scientific names are those recommended by Robins et al. (1980). One exception is that the common name suggested by Legendre et al. (1975) is utilized for *Acantholumpenus mackayi*.

Table 2. Total catch data from plankton net tows in Tuktoyaktuk Harbour, during 11 July - 16 August, 1982.

Species	Depth(m)	# Captured	Volume(m^3)	#·$100m^{-3}$
RNSM	0 - 1.0	997	7 880.0	12.7
	2.5 - 3.9	62	1 358.5	4.6
	4.0 - 7.5	94	3 359.9	2.8
	7.6 - 10.5	11	1 688.6	0.7
	Total	1 164	14 287.0	8.1
PCHR	0 - 1.0	69	7 880.0	0.9
	2.5 - 3.9	2	1 358.5	0.1
	4.0 - 7.5	18	3 359.9	0.5
	7.6 - 10.5	0	1 688.6	0
	Total	89	14 287.0	0.6
SFCD	0 - 1.0	1	7 880.0	<0.05
	2.5 - 3.9	6	1 358.5	0.4
	4.0 - 7.5	29	3 359.9	0.9
	7.6 - 10.5	1	1 688.6	0.1
	Total	37	14 287.0	0.3
STFL	0 - 1.0	0	7 880.0	0
	2.5 - 3.9	3	1 358.5	0.2
	4.0 - 7.5	18	3 359.9	0.5
	7.6 - 10.5	0	1 688.6	0
	Total	21	14 287.0	0.1
LUMP	0 - 1.0	0	7 880.0	0
	2.5 - 3.9	5	1 358.5	0.4
	4.0 - 7.5	3	3 359.9	0.1
	7.6 - 10.5	0	1 688.6	0
	Total	8	14 287.0	0.1
FHSC	0 - 1.0	5	7 880.0	0.1
	2.5 - 3.9	0	1 358.5	0
	4.0 - 7.5	0	3 359.9	0
	7.6 - 10.5	1	1 688.6	0.1
	Total	6	14 287.0	<0.05
ARCD	0 - 1.0	0	7 880.0	0
	2.5 - 3.9	2	1 358.5	0.1
	4.0 - 7.5	1	3 359.9	<0.05
	7.6 - 10.5	0	1 688.6	0
	Total	3	14 287.0	<0.05

Table 3. Catch data from surface plankton net tows in Tuktoyaktuk Harbour during 1982. Stations 7 through 8 are considered peripheral to and stations 10 through 15 within the main harbour area.

Station	Species	Period[1] 11, 12 July #	vol(m^3)	#·100m^{-3}	13-19 July #	vol(m^3)	#·100m^{-3}	20-26 July #	vol(m^3)	#·100m^{-3}	3-9 August #	vol(m^3)	#·100m^{-3}	10-16 August #	vol(m^3)	#·100m^{-3}	Total #	vol(m^3)	#·100m^{-3}
7	RNSM	41	228.9	17.9	2	152.4	1.3	0	135.1	0	0	69.7	0	0	151.9	0	43	738.0	5.8
	PCHR	25		10.9	1		0.7	0		0	1		1.4	0		0	27		3.7
	FHSC	1		0.4	0		0	0		0	0		0	0		0	1		0.1
17	RNSM	77	152.6	50.5	1	111.2	0.9	1	72.7	1.4		-			-		79	336.5	23.5
	PCHR	1		0.7	1		0.9	0		0							2		0.8
18	RNSM		-		1	122.9	0.8	3	136.4	2.2		-			-		4	259.3	1.5
9	RNSM	81	152.6	53.1	9	131.1	6.9	1	125.0	0.8	0	130.3	0	2	164.4	1.2	93	703.4	13.2
	PCHR	1		0.7	0		0	0		0	0		0	1		0.6	2		0.3
11	RNSM	18	76.3	23.6	33	158.1	20.9	2	146.5	1.4	2	154.2	1.3	0	75.1	0	55	610.2	9.0
19	RNSM		-		5	176.6	2.8	5	143.3	3.5		-			-		10	319.9	3.1
	PCHR				0		0	1		0.3							1		0.3
8	RNSM	91	152.6	59.6	2	129.8	1.5	2	129.2	1.5	0	133.9	0	0	72.8	0	95	618.3	15.4
	PCHR	1		0.7	0		0	0		0	0		0	0		0	1		0.2
10	RNSM	3	76.3	3.9	112	267.3	41.9	5	129.7	3.9	30	134.1	22.4	0	157.8	0	150	765.2	19.6
	PCHR	1		1.3	1		0.4	1		0.8	7		5.2	0		0	10		1.3
	FHSC	0		0	2		0.7	2		1.5	0		0	0		0	4		0.5
	SFCD	0		0	0		0	0		0	1		0.1	0		0	1		0.1
12	RNSM		-		44	401.7	11.0	8	166.0	4.8	1	166.8	0.6	0	157.0	0	53	891.5	5.9
	PCHR				4		1.0	0		0	0		0	0		0	4		0.4
13	RNSM	80	305.2	26.2	42	200.9	20.9	34	141.7	24.0		-			-		156	647.8	24.1
	PCHR	2		0.7	8		4.0	4		2.8							14		2.2
14	RNSM		-		184	206.9	88.9	21	392.5	5.4	0	137.1	0	3	310.1	1.0	208	1 179.9	17.6
	PCHR				1		0.5	0		0	0		0	3		1.0	4		0.3
15	RNSM		-		39	350.4	11.1	0	133.2	0	11	171.0	6.4	1	155.7	0.6	51	810.3	6.3
	PCHR				3		0.9	0		0	1		0.6	0		0	4		0.5
All Stations	RNSM	391	1 144.5	34.2	474	2 409.3	19.7	82	1 851.3	4.4	44	1 097.1	4.0	6	1 244.8	0.5	997	7 880.0	12.7
	PCHR	31		2.7	19		0.8	6		0.3	9		0.8	4		0.3	69		0.9
	FHSC	1		0.1	2		0.1	2		0.1	0		0	0		0	5		0.1
	SFCD	0		0	0		0	0		0	1		0.1	0		0	1		<0.05

[1]During the period 27 July - 2 August only Station 14 was sampled - volume was 133.3m^3 and catch was 0.

Table 4. Catch data from plankton net tows at different depth ranges in Tuktoyaktuk Harbour during 1982.

Depth(m)	Species	Station	Period																				
			12 July			13-19 July			20-26 July			27 July - 2 August			3-9 August			10-16 August			Total (Periods and Stations)		
			#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$
0-1.0	RNSM	13	72	305.2	23.6	42	200.9	20.9	34	141.7	24.0		-			-			-		356	1 827.7	19.5
		14		-		184	206.9	88.9	21	392.5	5.4	0	133.3	0	0	137.1	0	3	310.1	1.0			
	PCHR	13	2	305.2	0.7	8	200.9	4.0	4	141.7	2.8		-			-			-		16		0.9
		14		-		1	206.9	0.5	0	392.5	0	0	133.3	0	0	137.1	0	3	310.1	1.0			
2.5-3.9	RNSM	13		-		8	178.0	4.5	15	134.0	11.2		-			-			-		62	1 358.5	4.6
		14		-		1	79.5	1.3	33	406.0	8.1	1	145.4	0.7	2	137.7	1.5	2	277.9	0.7			
	PCHR	13		-			-		1	134.0	0.7		-			-			-				
		14		-		0	79.5	0	1	406.0	0.2	0	145.4	0	0	137.7	0	0	277.9	0	2		0.1
	SFCD	13		-		5	178.0	2.8	0	134.0	0		-			-			-		6		0.4
		14		-		1	79.5	1.3	0	406.0	0	0	145.4	0	0	137.7	0	0	277.9	0			
	LUMP	13		-		4	178.0	2.2	0	134.0	0		-			-			-		5		0.4
		14		-		1	79.5	1.3	0	406.0	0	0	145.4	0	0	137.7	0	0	277.9	0			
	ARCD	13		-		2	178.0	1.1	0	134.0	0		-			-			-		2		0.1
	STFL	14		-		0	79.5	0	0	406.0	0	0	145.4	0	3	137.7	2.2	0	277.9	0	3		0.2
4.0-7.5	RNSM	13		-			-			-		85	998.7	0.9	5	559.2	0.9	0	746.8	0	94	3 359.9	2.8
		14		-		2	70.1	2.9	0	407.0	0	1	164.9	0.6	1	137.2	0.7	0	276.0	0			
	PCHR	13		-			-			-		18	998.7	1.8	0	559.2	0	0	746.8	0	18		0.5
	SFCD	13		-			-			-		10	998.7	1.0	2	559.2	0.4	5	746.8	0.7	29		0.9
		14		-		1	70.1	1.4	9	407.0	2.2	1	164.9	0.6	1	137.2	0.7	0	276.0	0			
	LUMP	13		-			-			-		2	998.7	0.2	1	559.2	0.2	0	746.8	0	3		0.1
	ARCD	14		-		0	70.1	0	1	407.0	0.2	0	164.9	0	0	137.2	0	0	276.0	0	1		<0.05
	STFL	13		-			-			-		14	998.7	1.4	4	559.2	0.7	0	746.8	0	18		0.5
7.6-10.5	RNSM	13		-		5	159.9	3.1		-			-			-			-		11	1 688.6	0.7
		14		-		2	693.1	0.3	3	329.5	0.1	1	125.6	0.8	0	129.2	0	0	251.3	0			
	SFCD	14		-		0	693.1	0	0	324.5	0	0	125.6	0	0	129.2	0	1	251.3	0.4	1		0.1
	FHSC	14		-		1	693.1	0	1	329.5	0.3	0	125.6	0	0	129.2	0	0	251.3	0	1		0.1

Table 5. Catch data from plankton net tows at different depth ranges in Kugmallit Bay, N.W.T., during 1982.

Depth(m)	Species	Period														
		13-19 July			27 July - 2 August			3-9 August			10-16 August			Total		
		#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$	#	vol(m^3)	#·$100m^{-3}$
0-1.0	RNSM	9	420.3	2.1	0	157.2	0	0	148.1	0	0	149.8	0	9	875.4	1.0
	PCHR	0		0	1		0.6	0		0	0		0	1		0.1
	ARCD	3		0.7	0		0	0		0	0		0	3		0.3
	FHSC	3		0.7	0		0	0		0	0		0	3		0.3
2.5-3.9	RNSM	0	321.8	0	1	101.6	1.0	0	140.3	0	0	158.2	0	1	721.9	0.1
	PCHR	0		0	0		0	1		0.7	0		0	1		0.1

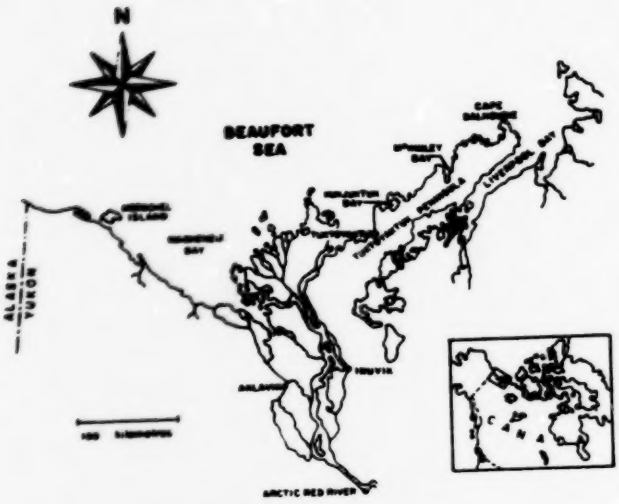

Fig. 1. The Mackenzie Delta-Beaufort Sea area.

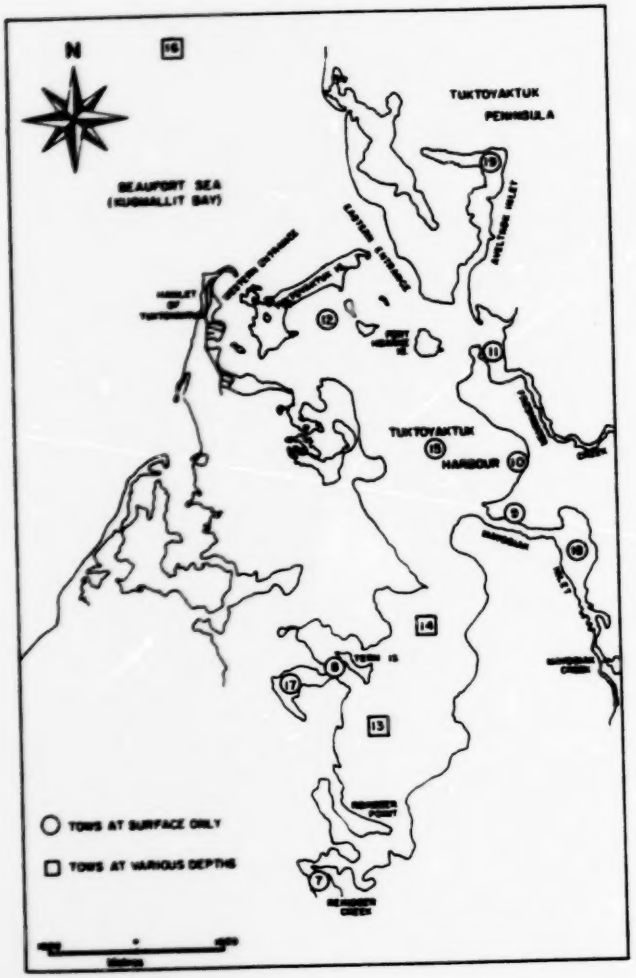

Fig. 2. Tuktoyaktuk Harbour indicating stations sampled.

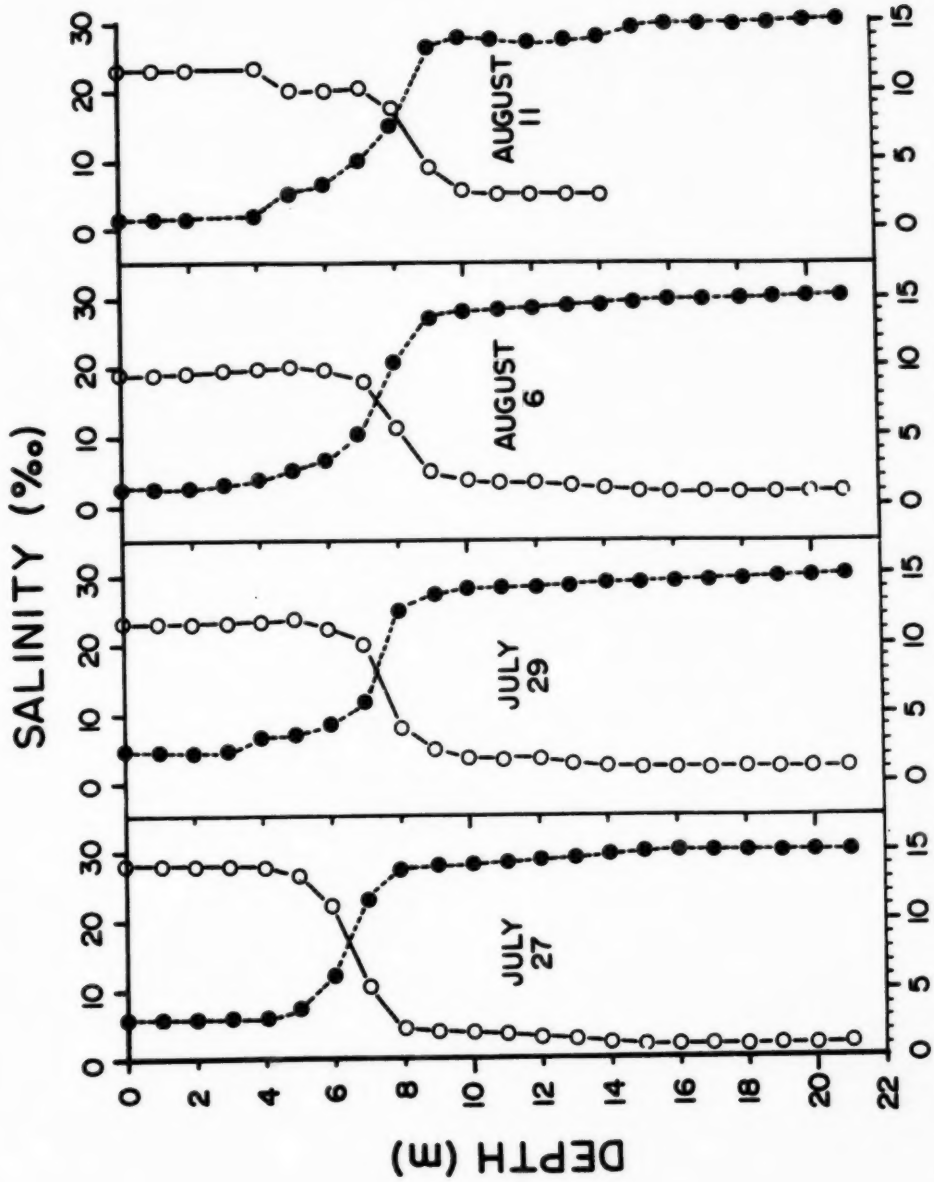

Fig. 3. Salinity (solid circles) and temperature (open circles) profiles, at several occasions during 1982, from Tuktoyaktuk Harbour.

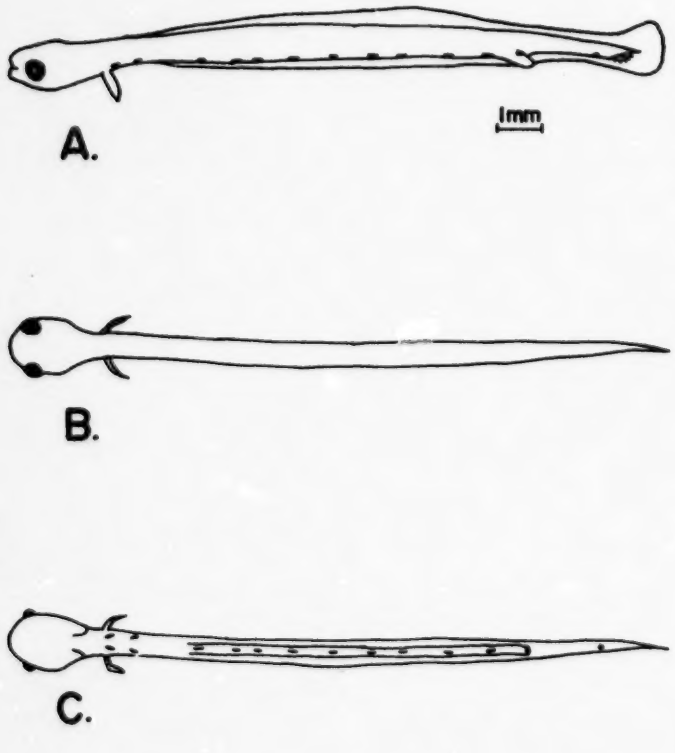

Fig. 4. Postlarval rainbow smelt (14.7 mm total length) from Tuktoyaktuk Harbour, A) lateral, B) dorsal, and C) ventral views.

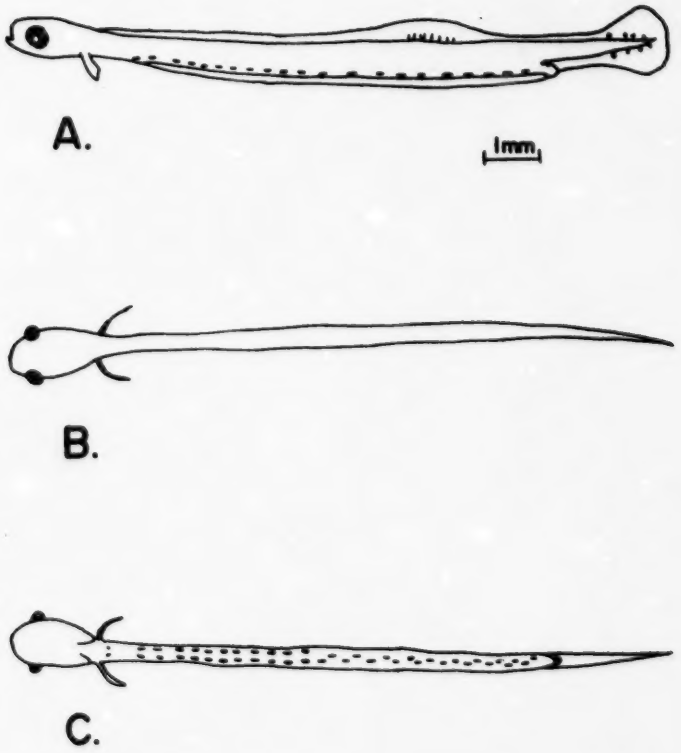

Fig. 5. Postlarval Pacific herring (12.0 mm total length) from Tuktoyaktuk Harbour, A) lateral, B) dorsal, and C) ventral views.

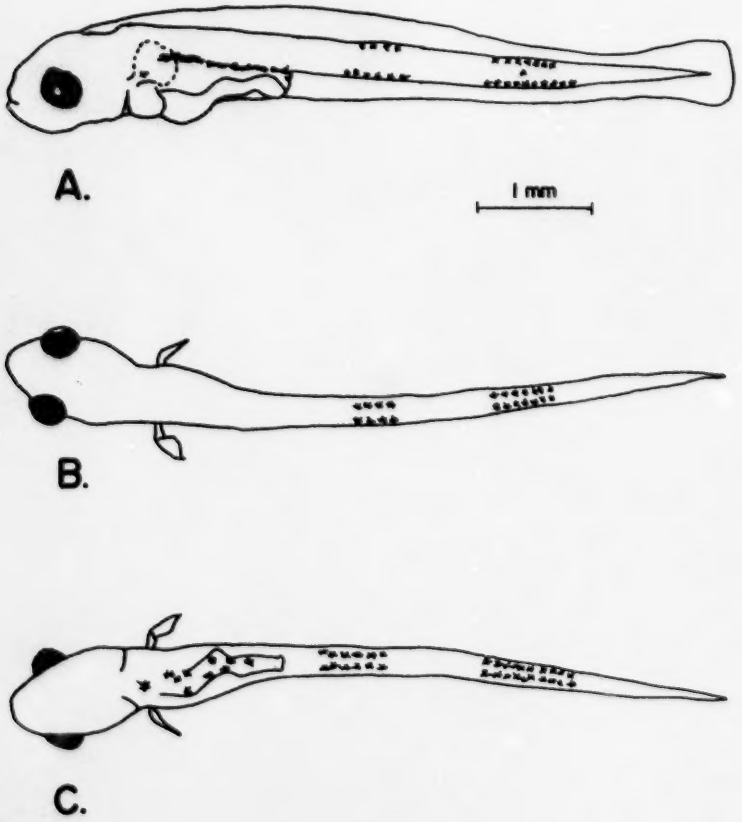

Fig. 6. Postlarval saffron cod (6.4 mm total length) from Tuktoyaktuk Harbour, A) lateral, B) dorsal, and C) ventral views.

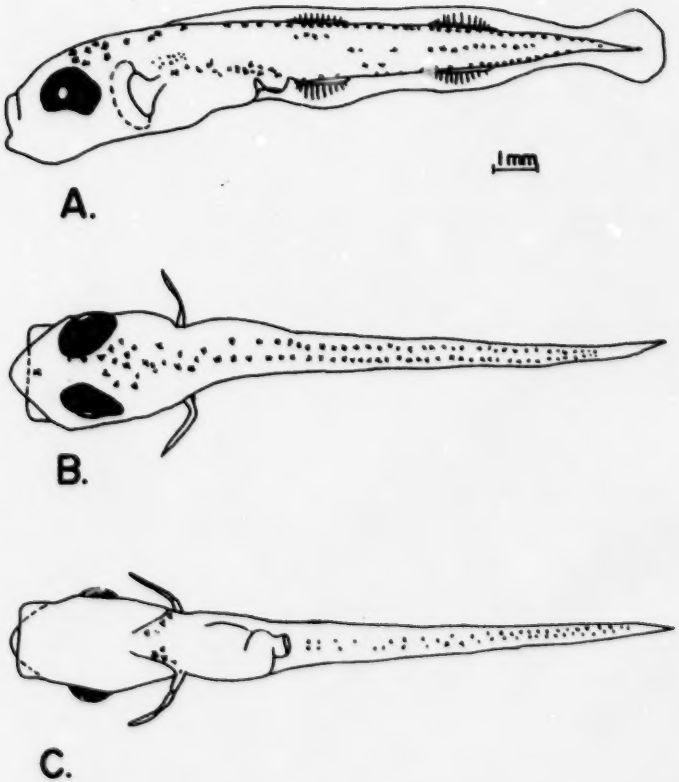

Fig. 7. Postlarval Arctic cod (14.6 mm total length) from Tuktoyaktuk Harbour, A) lateral, b) dorsal, and C) ventral views.

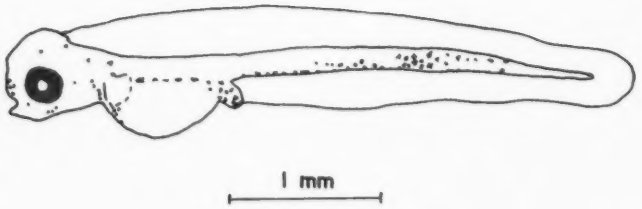

Fig. 8. Prolarval starry flounder (4.1 mm total length) from Tuktoyaktuk Harbour, lateral view.

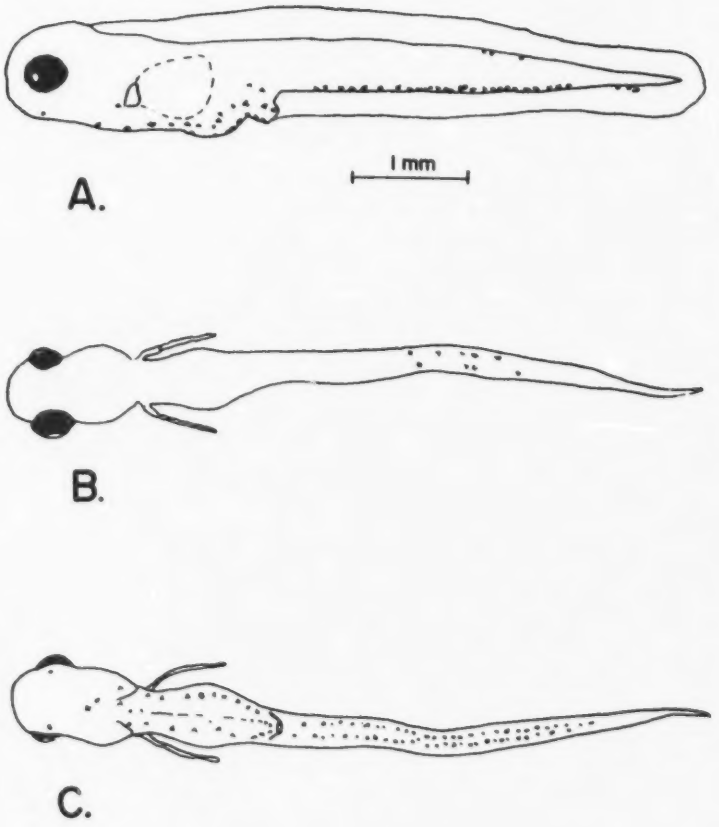

Fig. 9. Postlarval pleuronectid (6.0 mm total length), probably starry flounder, from Tuktoyaktuk Harbour, A) lateral, B) dorsal, and C) ventral views.

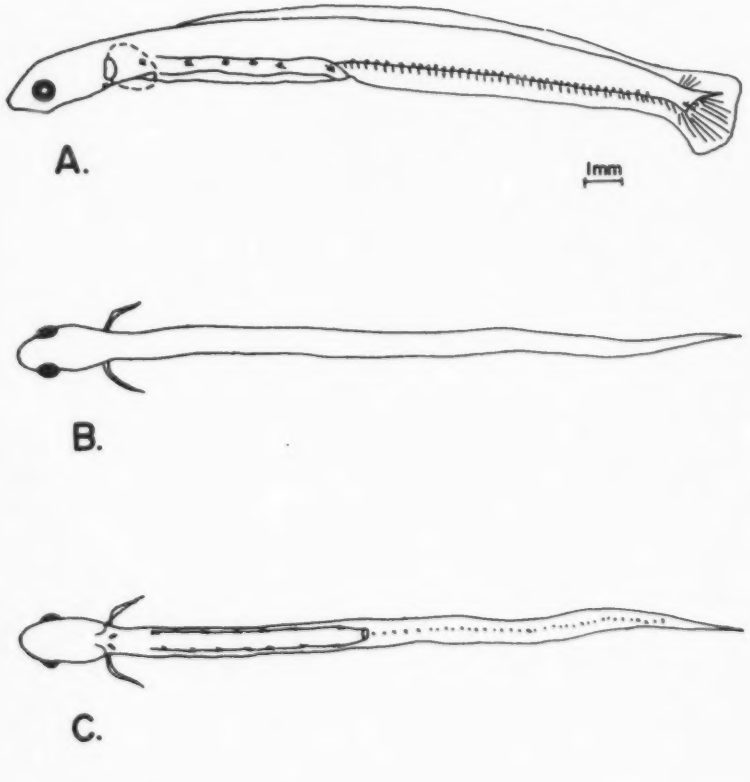

Fig. 10. Postlarval lumpenid (20.0 mm total length) from Tuktoyaktuk Harbour, A) lateral, B) dorsal, and C) ventral views.

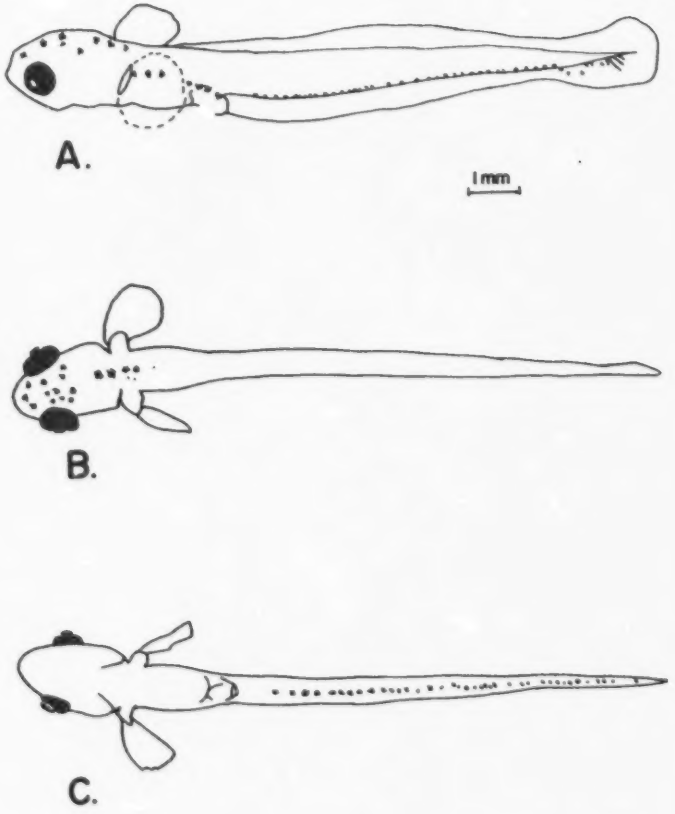

Fig. 11. Postlarval fourhorn sculpin (12.7 mm total length) from Tuktoyaktuk Harbour, A) lateral, B) dorsal, and C) ventral views.

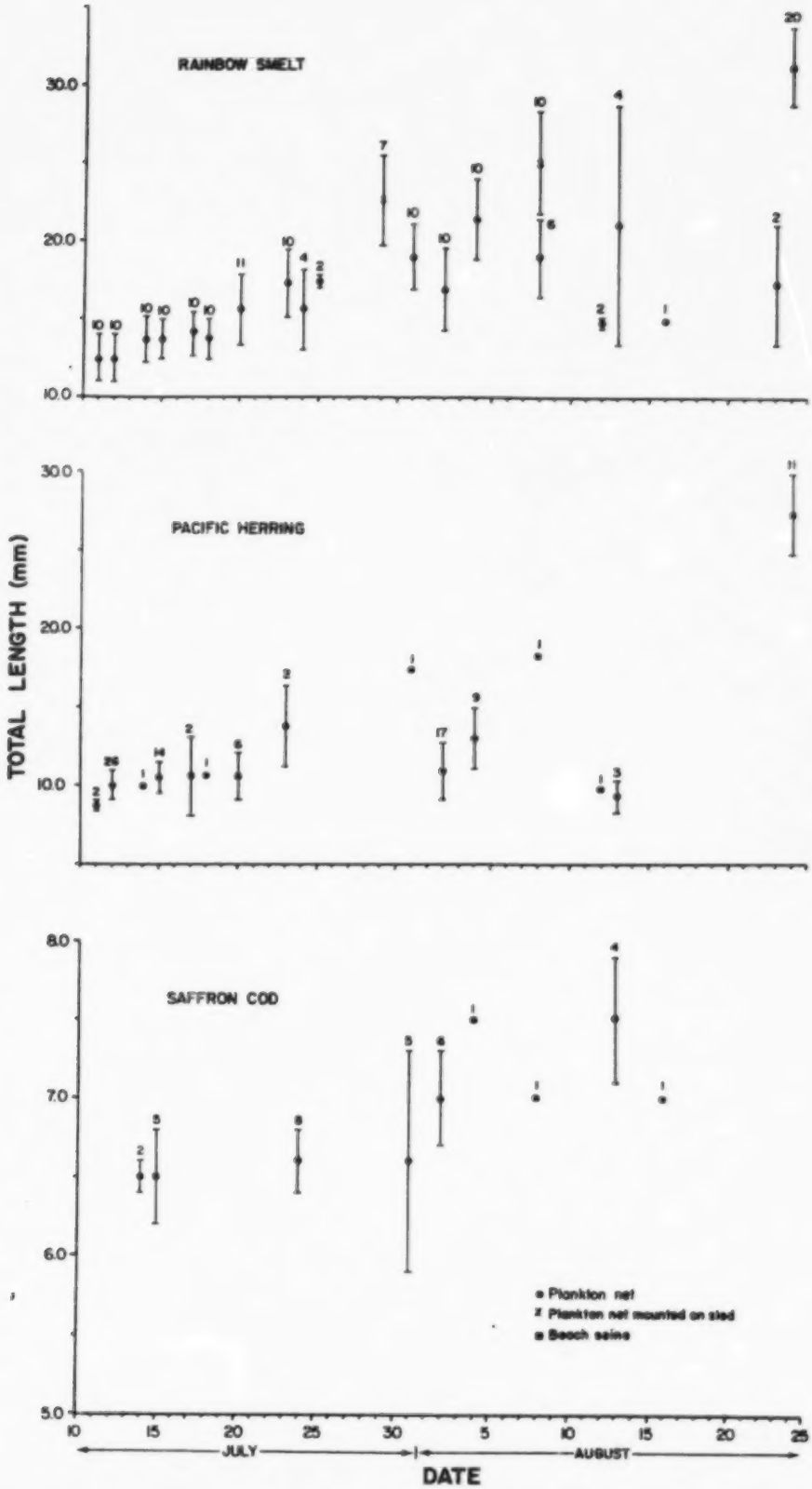

Fig. 12. Mean length of rainbow smelt, Pacific herring, and saffron cod at various dates.